

**Title: Liver Lab****Brief Overview:**

This is a science lesson that can be used either during a digestive unit or chemistry unit. Students will use beef liver as a source of catalase to speed up the reaction of the breakdown of hydrogen peroxide to water and oxygen. They will observe how factors such as surface area, temperature, and pH affect the rate of a chemical reaction.

**Links to National Science Education Standards:**

- **Unifying Concepts and Processes**

Students will demonstrate their ability to use systems, order, and organization as well as use evidence, models and explanation as these skills apply to any laboratory setting.

- **Science as Inquiry**

Students will demonstrate their ability to use their understanding of scientific inquiry as they make hypotheses guided by their teacher, test these hypotheses, and use their observations to make conclusions on the effects of surface area, temperature, and pH on the rate of a chemical/biological reaction.

- **Physical Science**

Students will demonstrate their understanding of chemical reactions as they first identify the reaction of the breakdown of hydrogen peroxide into water and oxygen, then identify the role of an enzyme in this reaction, and finally identify factors effecting this particular reaction.

- **Life Science**

Students will demonstrate their understanding of matter, energy, and organization in living systems as they identify that heating the liver denatures the protein (enzyme), and therefore the reaction cannot take place. Students know that often heat speeds up a reaction, but will be able to now distinguish between experimental procedures and biological procedures.

**Links to Maryland High School Science Core Learning Goals**

- **Concepts of Biology**

Students will demonstrate their understanding of the role of enzymes in biological reactions. They will identify the effect of heat on proteins, and make the connection to the danger of running a high temperature.

- **Concepts of Chemistry**

Students will demonstrate their understanding of catalytic reactions, and the effects of temperature, surface area, and pH on these reactions. They will specifically identify the reaction of the breakdown of hydrogen peroxide to oxygen and water.

**Grade/Level:**

Grades 9-12

**Duration/Length:**

One class period

**Prerequisite Knowledge:**

Students should have working knowledge of the following:

- Decomposition chemical reactions
- The role of enzymes in a reaction
- General structure of proteins

**Student Outcomes:**

Students will:

- be able to analyze scientific data to determine the effects of temperature, pH, and surface area on catalytic reactions.
- be able to apply their conclusions to the effects of these factors in living organisms.

**Materials/Resources/Printed Materials:**

- |                                 |                     |
|---------------------------------|---------------------|
| • Copy of “Liver Lab”           | • Wooden Splints    |
| • Test tube holder              | • Sand              |
| • Tongs                         | • Plastic pipet     |
| • H <sub>2</sub> O <sub>2</sub> | • Ring Cover        |
| • Ring Stand                    | • Beef Liver        |
| • 1 M NaOH                      | • Beaker            |
| • Test tubes                    | • Mortar and pestle |
| • MnO <sub>2</sub>              | • Bunsen Burner     |
| • 1 M HCl                       | • Ice               |

**Development Procedures:**

- Students will perform the lab experiment according to the given procedures. They should recognize the first reaction as the control, and as the comparison for the foaming action of the other trials.
- Students will collect data, recording the foaming intensity for each reaction.
- Students will analyze their data individually or as a class, guided by the provided questions for analysis/discussion.

**Assessment:**

Students will either hand in written answers to the questions or a lab report, using the questions as a guide to writing their conclusions. The students will be scored according to the rubric included.

**Extension/Follow Up:**

- If this lesson is used during a digestion unit, you may choose to follow up with a discussion of the importance of both physical and chemical digestion, highlighting how both the surface area and the presence of a catalyst effected the reaction.
- If this lesson is used during a chemistry unit, you may choose to use this as a lab to demonstrate a simple decomposition reaction with a real-world connection.
- Students are often interested in the fact that heating the liver denatured the protein, as they often expect heat to speed up a reaction. You may choose to take this opportunity to discuss this concept.

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# Liver Lab

## Background

Much of life is a series of on-going chemical reactions. The interactions between the chemicals we eat and drink sustain life. Most of these reactions would not take place without the help of catalysts or enzymes. Catalysts and enzymes generally speed up the rate of a reaction by providing additional surface area for the reactants to come together. The enzyme catalase is found in liver. This enzyme is responsible for the rapid breakdown of hydrogen peroxide,  $\text{H}_2\text{O}_2$ , to water and oxygen. However, you will find that there are other factors that influence the rate of a reaction.

## Objective

To use the enzyme catalase and investigate other factors that influence the rate of a reaction.

## Materials

Test tube holder	Wooden Splints	Mortar and pestle	Test tubes
Tongs	Sand	$\text{MnO}_2$	Beaker
$\text{H}_2\text{O}_2$	Plastic pipet	Bunsen Burner	
Ring stand	Ring cover	1 M $\text{HCl}$	
1 M $\text{NaOH}$	Beef liver	Ice	

## Procedure

1. Start a hot water bath. The water does not need to be boiling, but it needs to be very hot.
2. Add 2 mL of  $\text{H}_2\text{O}_2$  to a test tube. Then add a small amount of sand. Use a scale of 0 to 5, with 5 the most intense, to record the intensity of any foaming action.
3. Add 2 mL of  $\text{H}_2\text{O}_2$  to a clean test tube. Then add 0.1 g manganese dioxide. Record the foam intensity. Now place a glowing splint in the test tube. Describe what happens. What gas is produced by this lab?
4. Cut a piece of beef liver into pieces small enough to fit through the opening of the test tubes. Place one piece in very hot water, one piece in ice water, one piece in  $\text{HCl}$ , and another piece in  $\text{NaOH}$ . As these soak, perform the following for another two pieces of liver.
  - a. Liver #1: Place a solid chunk of liver into a test tube. Use a wooden splint to push the liver to the bottom of the test tube. Add 2 mL  $\text{H}_2\text{O}_2$ . Record the intensity of the foaming action.
  - b. Liver #2: Place a solid chunk of liver into the mortar with enough sand to cover it. Use the pestle to grind the chunk of liver into smaller pieces. Place the liver mush into a test tube. Push the liver mush to the bottom with a wooden splint and add 2 mL of  $\text{H}_2\text{O}_2$ . Record the intensity of the foam.

- c. Liver #3: Use the tongs to remove a sample of liver from the very hot water. Place the liver in a test tube and push the liver sample to the bottom with a wooden splint. Then add 2 mL of  $\text{H}_2\text{O}_2$ . Record the intensity of the foam.
- d. Liver #4: Remove a liver sample from the ice water. Place the liver in a test tube and add 2 mL of  $\text{H}_2\text{O}_2$ . Record the intensity of the foam.
- e. Liver #5: Use the tongs to remove the liver from the HCl solution. Place the liver in a test tube and add 2 mL of  $\text{H}_2\text{O}_2$ . Record the intensity of the foam.
- f. Liver #6: Use the tongs to remove the liver from the NaOH solution. Place the liver in a test tube and add 2 mL of  $\text{H}_2\text{O}_2$ . Record the intensity of the foam.

### Data

Liver #	Foam Intensity
<b>MnO<sub>2</sub> &amp; H<sub>2</sub>O<sub>2</sub></b>	
1	
2	
3	
4	
5	
6	

### Questions for Analysis/Discussion

1. There are several factors that can have an effect on the rate of a chemical reaction. These factors are concentration, surface area, temperature, the nature of the reactants used, and catalysts.
  - a. Which liver sample is the control for this lab? How do you know?
  - b. Which liver sample's chemical reaction was affected by temperature?
  - c. Which liver sample's chemical reaction was affected by surface area?
  - d. How would an increased concentration of the HCl acid solution and the NaOH solution affect the rates of reactions that occurred during this lab?
2. What problem do you think a person might have if they get a very high fever?

## **Analysis Scoring Rubric**

- 3** Analysis of data shows complete understanding of the scientific concepts involved.
- 2** Analysis of data shows some understanding of the scientific concepts involved.
- 1** Analysis of data show little or no understanding of the scientific concepts involved.